STEM FAIR Guide

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Introduction

The DC STEM Fair is an Office of the State Superintendent of Education (OSSE)-sponsored activity that supplements the regular curriculum of classroom instruction. The purpose of the Science, Technology, Engineering and Math (STEM) Fair is to encourage students' interest in science, to develop their inquiry and investigation skills, and to enhance pride in completing research projects.

Elementary-level science exhibitions

• Enable students to exhibit their projects and share ideas with other students and community members

• Provide opportunities for students to receive feedback from professional scientists and community members

• Provide students with exciting opportunities to work with science process skills and the scientific method on a topic of their own choosing that relates to the science curriculum as it connects to real life.

Secondary-level science fair:

• Enable students to showcase their projects and research ideas and compete with other students and community members for placement ranking.

• Provide opportunities for students to receive feedback from professional scientists and community members

• Provide students with exciting opportunities to work with science process skills and the scientific method on a topic of their own choosing that relates to the science curriculum as it connects to real life.

What is a Science Project?

A science fair project is a unique way for students to pose questions for which they must seek out answers and to satisfy their own curiosity about the world around them. A science fair project is an experiment, a research effort, a collection of scientific items, or display of scientific apparatus presented for viewing. It represents the efforts of a student's investigation into some area of interest and provides a way for the student to share the results of those investigations. Through the development of a science fair project, students gain a first-hand appreciation of the work of scientists and the value of their discoveries.

Science Fair Rules and Guidelines

1. Group projects of no more than 4 students may enter exhibition.

2. Only two types of projects may be entered into the District Fair, they are a scientific investigation or an invention.

3. Projects must fit in one of the 11 science fair project category criteria listed in this handbook.

4. **No mold growth, or bacteria projects are allowed**.

5. **No use of vertebrate animals is allowed except for human observational projects**.

6. **No use of prescription drugs, harmful, or illegal substances are allowed.** Grocery items (i.e., baking soda, vinegar, salt, lemon juice, etc.) are appropriate.

7. No Human subjects used to test (i.e., taste test, poking, pain reaction, sniffing, etc.)

8. Any projects that promote violence, weapons, or instill fear to the public, the exhibitor, or other exhibitors and the use of fire are PROHIBITED.

9. Project display boards must follow safety guidelines listed in this handbook.

10. Projects must be approved by the classroom teacher or a science fair committee.

Science Fair: Areas of Science

Physical Science:
Projects that study the nature and properties of nonliving matter, energy and/or force and motion.

Behavioral Science:
Projects that observe the behavior of invertebrate animals. **The use of vertebrate animals** is not allowed except for human observational projects (example: Do boys have a faster reaction time than girls?).

Botany:
Projects that use subjects such as plants (mosses, seed plants), agriculture, conservation, and forestry. **NO LIVE PLANTS** may be displayed. **Experiments using mold or fungi are NOT allowed**.

Chemistry:
Projects that examine chemical reactions, the chemistry of living things, photosynthesis, solubility, heat capacity, etc. **No prescription drugs, dangerous or illegal substances should be used** in the experiments.

Earth and Space Science:
These are projects investigating principles of geology (for example, weathering and erosion), geography, astronomy, meteorology, and related fields.

Engineering: Projects can develop technological devices, which are useful to the global society within an engineering-related field, such as electricity, mechanical, chemical, aeronautical, and geological.

Environmental Science:
Projects that deal with global change, issues related to Earth, such as water, air, climate, waste and pollution, green living, human health, ecosystems and related fields.

Medicine and Health:
The project's emphasis will be on human health. (STUDIES ARE LIMITED TO OBSERVATIONAL PROJECTS ONLY.)

Zoology:
Projects that observe and record the growth or behavior of animals **(INVERTEBRATES).** VERTEBRATE STUDIES ARE LIMITED TO OBSERVATIONAL PROJECTS ONLY.

Mathematics:
Projects are developed that demonstrate any theory or principal of mathematics.

Inventions: projects that uses design and engineering processes to find a practical solution to a problem that addresses a need that exists for people in general or a person with a specific handicap.

Types of projects: Scientific Method vs Engineering Design Method

The goal of a scientist is to answer questions and discover information about the natural world, while an engineer focusses on creating products or process that solve a problem.

The difference between engineering and scientific method are:

- Scientists use the scientific method, which involves asking a question, doing background research, formulating a hypothesis, testing the hypothesis by conducting and experiment, analyzing the data and communicating the results.

- The engineering design process involves defining a problem, brainstorming solutions, selecting the best solution, developing, and testing a prototype and improving the design.

[Which should you choose? Scientific Method versus Engineering Design Process (youtube.com)]

The Scientific Method- Experiment Design Process

The Scientific Method is an organized way of figuring something out. There are usually six parts to it.

1.**Purpose/Question**- What do you want to learn?

Begin by exploring a scientific concept in which you are interested. This can be something that was read about or were introduced in the classroom. Go to the library or internet to learn more about your topic. Write a brief summary of the background information you gather for your science fair topic. Keep a record of where the background information came from. This information will be listed in your bibliography in Step 12.

At this point, your brain will start asking "What **if**...." questions. One of these questions is what you will use to design your experiment. It is called the "**TESTABLE QUESTION**”. This will become your problem statement. Make sure that this has been approved by your teacher.
Anything to do with your project should be recorded.

- An example would be, "What doorknob in school has the most germs?" or "Do girls have faster reflexes than boys?" or "Does the color of a light bulb affect the growth of grass seeds?"

2.**Research**- Find out as much as you can.

- Look for information in books, on the internet, and by talking with teachers to get the most information you can before you start experimenting. Record all information and sources

3.**Hypothesis**- After doing your research, try to predict the answer to the problem.

- Another term for hypothesis is 'educated guess'. This is usually stated like " If I...(do something) then...(this will occur)" An example would be, "If I grow grass seeds under green light bulbs, then they will grow faster than plants growing under red light bulbs."
- Think about what might happen in your experiment. This is called a **HYPOTHESIS**. Write down what you think will happen BEFORE actually doing the experiment.
- How do you design the experiment to answer your question?
- What measurements do you need to take to record your results?
- Be specific.

4.**Experiment**- The fun part! Design a test or procedure to find out if your hypothesis is correct.

- **Procedure**
  Write a detailed description of how to do your experiment. As you work through it, you may find that you have to change it. Make notes and change your procedure afterwards, to show the changes. Remember, any scientist should be able to take your procedure and repeat your experiment following your instructions.
  • It is easier to use a numbered list, like in a cookbook rather than write a paragraph.
  • Start each sentence with an action verb: mix, stir, get, measure, etc.
  • Include quantities or amounts that you will measure using metric units.

- **Materials/Equipment**
  Now that you have planned your experiment, gather all the materials you will need to do the experiment. As you begin the experiment, make detailed observations of what is happening. Take your measurements carefully. Keep written notes about what you do and how you do it. Display a list of materials used in column form with metric units identified. Make sure materials are available.

- **Variables and Control Group**
  - Identify the **test variable** (independent/manipulated). This is the variable that you are changing on purpose in your experiment to observe what will happen. For example, the temperature of the water or the battery strength.
  - Identify the **outcome variable** (dependent/responding variable), this is the one that reacts or changes in response to the **test** or independent/manipulated variable, i.e., amount of salt that dissolves or number of paper clips held by a magnet.
  - Identify the **constant variables** in your experiment. These are the variables in your experiment that you do not change so that you can compare the effects from only one **test** (independent/manipulated) **variable**. Constant variables are quantities that a scientist wants to remain the same or be held constant. Most experiments have more than one constant variable. Some people refer to controlled variables as "constant variables."
  - Use a **control group** if applicable in your experiment. A control group is the group that does not receive the experimental variable. Both it and the experimental group have what is usually considered normal conditions, i.e., room temperature, normal amount of water, normal amount of sunlight (constants). A control group helps you to be sure that what YOU DO in your experiment is affecting the test results.
- Observe and record the results in a data table using metric units i.e., centimeters (cm); grams (g); or degrees Celsius (˚C).
- If qualitative observations are made, a numbered scale must be developed to quantify the observations.
- Use photographs whenever possible to record observations. **(NO FACES IN PHOTOS).** These can be shown on the display board.

Then, ***REPEAT THE EXPERIMENT*** at least two more times. Record your results as carefully as you did the first time. ALL scientists repeat their experiments; we **INSIST** you repeat yours as well. All experiments must have a minimum of three trials.

- In our example, you would set up grass seeds under a green light bulb and seeds under a red light and observe each for a couple of weeks. You would also set up grass seeds under regular white light so that you can compare it with the others. If you are doing this for a science fair, you will probably have to write down exactly what you did for your experiment step by step.

5.**Results/Data**- Record what happened during the experiment. Also known as 'data'.

- As you observe your experiment, you will need to record the progress of your experiment.
- Data can be whatever you observe about your experiment that may or may not change during the time of the experimentation.
- When you have all of your results, you need to design the way that you will report the data.

Many students use graphs, charts and written summaries of what happened in the experiment.

- Use photographs whenever possible to show changes **(NO FACES IN PHOTOS).**
- Display all your data in charts, graphs, and/or pictures even if it does not match what you thought was going to happen under the heading Data on your display board.
- Explain your results in words and display this narrative under the heading Results on the display board.
- Examples of data are values in pH, temperature, a measurement of growth, color, distance, etc. Data should be shown in more than one way. Examples of ways to show date; graphs, tables, charts, models, pictures, realia, etc.

6. **Conclusion**- Review the data and check to see if your hypothesis was correct.

Look again at your **HYPOTHESIS** and at the results of your experiment. Think about what happened and why it happened that way. Determine if your hypothesis was supported or not supported. You will use your observations to help you write your Conclusion in the next step.

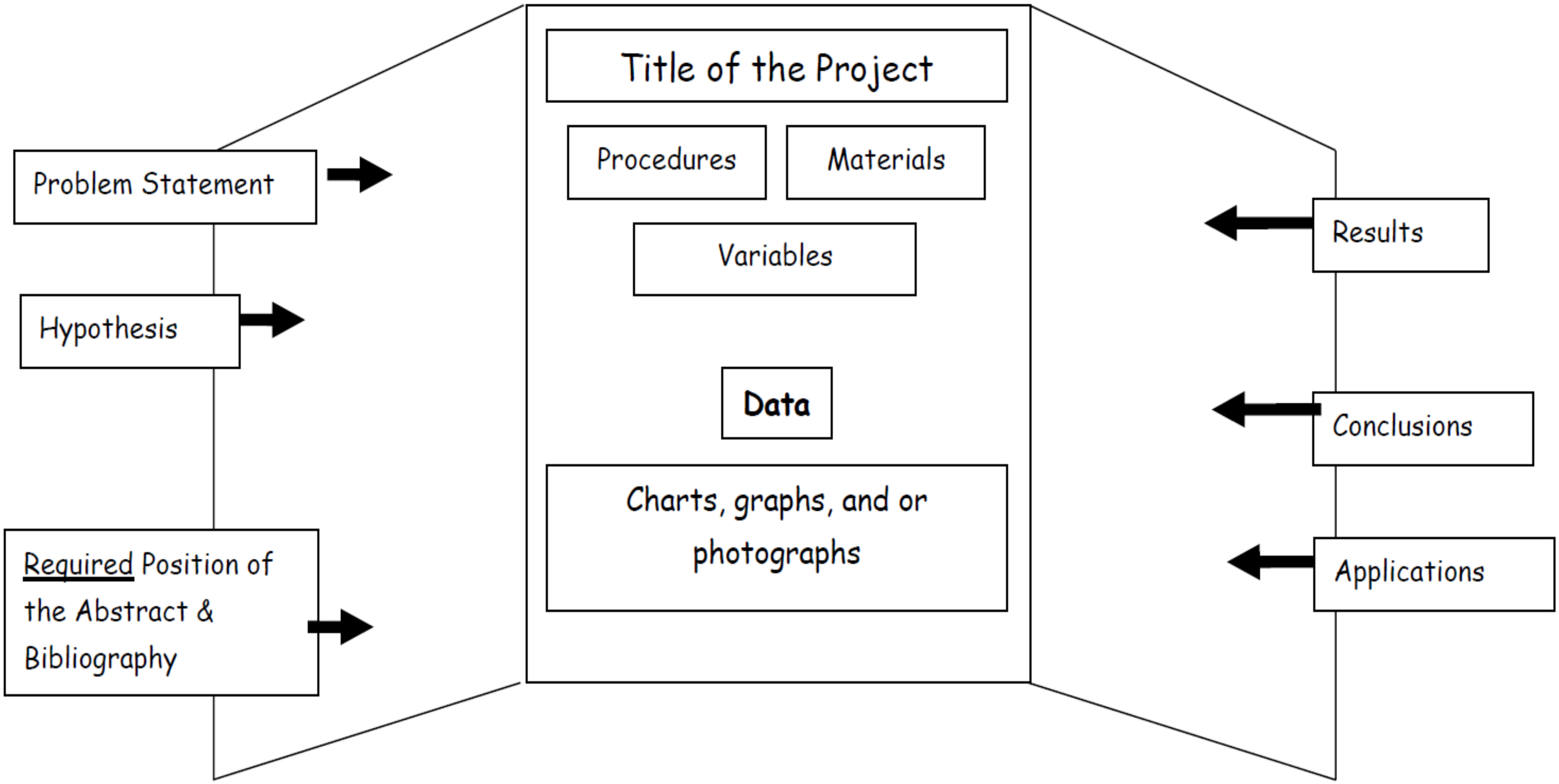
Answer the following questions to summarize what you have learned from the experiment.

- What was the purpose of the investigation?
- Was your hypothesis supported by the data? (Indicate evidence and reasoning that supports your conclusion. This is called Conclusion Evidence Reasoning (CER).
- What were the major findings? What are possible reasons for the results?

From our example:

If the grass under the green light bulb grew faster, then you proved your hypothesis, if not, your hypothesis was wrong. It is not "bad" if your hypothesis was wrong because you still discovered something! Your conclusion should also include next steps.

Scientific Method/ Experiment Design Board Display



The Engineering Design Process/ Invention Design

The Engineering Design Process consists of a series of steps that engineers follow to create solutions to problems.

An invention can be anything that solves a real problem. It is something that no one has ever thought of before. It cannot be purchased in a store or found in a book. Sometimes an invention is an improvement to an object that was already invented. An invention must serve a purpose!

1. **Identify The Problem**. It is crucial that this step not be completed without thorough consideration. Identifying the problem includes discerning what is needed as well as any constraints or rules that must be followed.

    - Focus on problems that you may have noticed during your daily life, i.e., opening a can of dog food, reaching the top shelf in your closet, having a place to sit as you wait in line.

2. Next comes **Brainstorming**! Creativity is king here, but it can also be overwhelming to know where to start in coming up with a feasible idea. Look at each material available and write out how each material may be useful in solving the problem.

    - What do you already know? Focus on originality. If an inventor has an idea, it is important to know what already exists so that the inventor does not waste time "reinventing the wheel." Call around to stores and do research in catalogs to find out if the invention already exists. Your parents may have to help you call stores because they will be taken more seriously. Be sure to record all this information in your notebook log.

3. **Research and Planning:** Before an invention can be successful, you must make a plan. Your plan should include all the steps you can think of, from beginning to end. When writing your plan, ask yourself questions such as these.
    - What can I read about that will help me with my invention?
    - Who can I talk to about solving problems and planning properly?
    - What materials will I need?
    - How can I control the cost of my invention?
    - What steps should I follow?
    - How much time should I allow for each step?
    - How can I test my invention?

Do not be surprised if you need to change your plans along the way. Sometimes a plan will not work as well as you first thought it would. So, keep an open mind for change. You may even discover a better way of completing a certain step.

4. Now for the **Design** phase! From the list made in the brainstorming step, a design may be drawn showing key components previously identified as important. Labeling each part in their sketch will help them in the next step as well as keep inventory of how much of each material is needed.

5. Then – Build! From their design sketch, engineers can bring their creations to life. Here, they may discover that some materials will not work as they had planned and some changes may be necessary.

6. Once the designs have been built, Testing may begin.

    - Follow your plan step-by-step. This step is where frustration may set-in and engineers may become discouraged if their design continues to fail. The key is teaching that failure is an important part of the Engineering Design Process. Failure is what shapes designs to their optimal performance. Because of this truth, failure should be celebrated as an opportunity to make something better!

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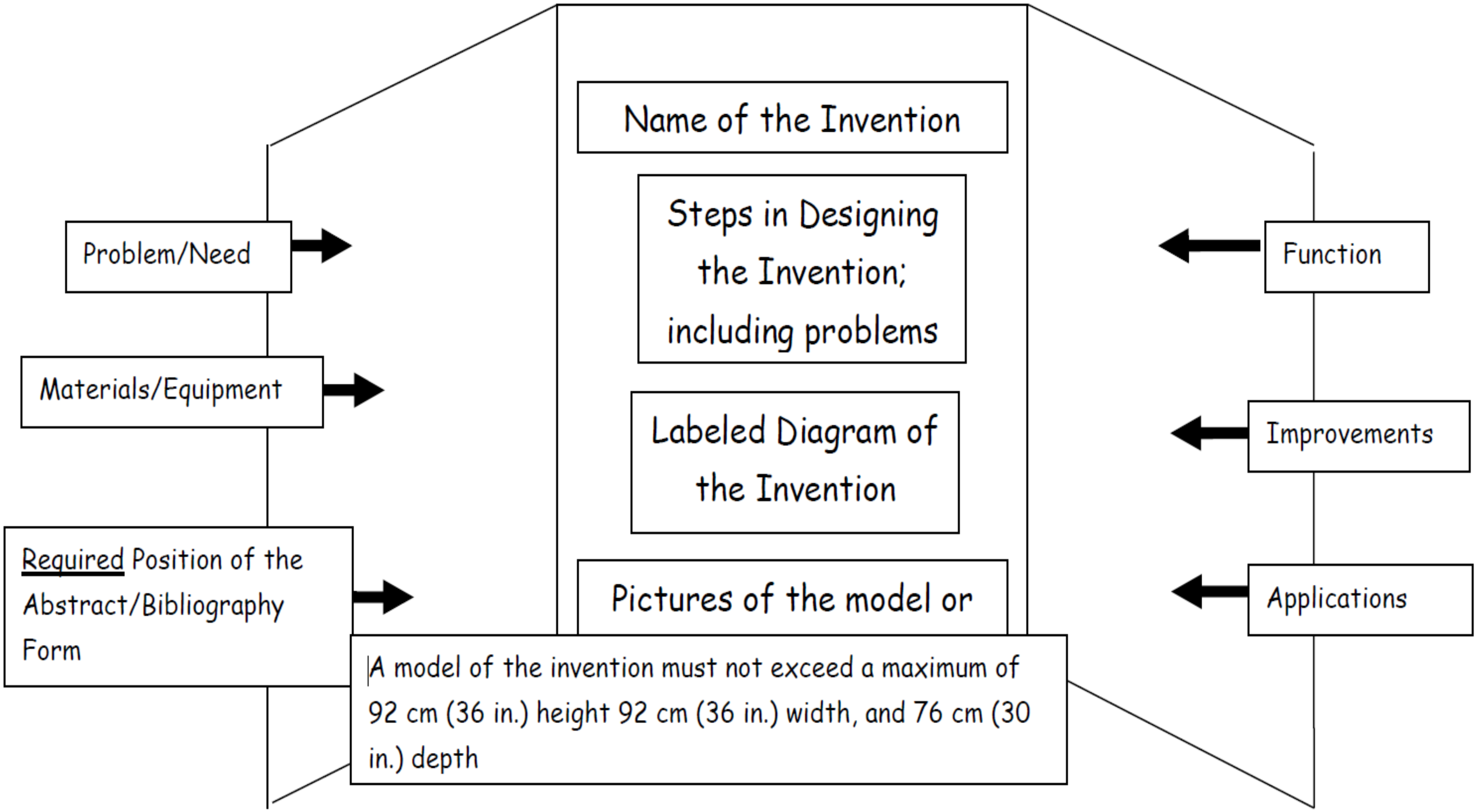
*Inventors are encouraged to use recycled materials. The cost of the invention must not exceed $25.

Engineering Design Process/Invention Display Board



Websites That May Be Helpful for Projects and Inventions:

http://www.sciencebob.com/sciencefair/index.php

http://www.invention-help.com/invention-help-books.htm

http://pbskids.org/designsquad/pdf/parentseducators/DS_Invent_Guide_Full.pdf **(teachers only)**

http://www.inventivekids.com/2010/10/05/step-by-step-guide-to-inventing/

http://www.sciencebuddies.org

http://www.showboard.com

http://science.dadeschools.net/

http://www.proteacher.com/110031.shtml

http://www.sciedunet.org

http://sciencepage.org/scifair.htm

http://my.integritynet.com.au/purdic/science-fair-projects-ideas.htm

http://www.ipl.org/div/kidspace/projectguide/

http://www.super-science-fair-projects.com/elementary-science-fair-projects.html

www.kidsinvent.org

www.howstuffworks.com

http://edweb.sdsu.edu/courses/EDTEC596/Project1/Inventors.html **(teachers only)**

http://ctinventionconvention.org/